

Effects of Supply Chain Disruption Risk on Organizational Performance of Manufacturing Firms in CALABARZON region

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Abstract

Countless disruptions around the world challenges the survival of any supply chain. This includes supply chains in developing countries like the Philippines. This paper has analyzed the effects of supply chain disruption risks on the organizational performance of manufacturing companies in the towns of Calamba, Laguna, Batangas, Rizal, and Quezon also known as (CALABARZON) region. The predictor variables are the disruption risks. These are from the supply-side (SDR), demand-side (DDR), process-side (PDR), and the environment (EDR). The criterion variables are supply chain performance (SCP) and firm performance (FP). Data was gathered using a 7-point Likert scale online questionnaire. Final data was analyzed using SPSS software. Only SDR and DDR have significant and negative effects on SCP ($p < 0.05$), as shown by the data from multiple regression analysis. Thus, both H_{01} and H_{02} were rejected. The study failed to reject both H_{03} and H_{04} . On the other hand, only PDR and EDR have significant and negative effects on FP ($p < 0.05$). Thus, both H_{07} and H_{08} were rejected. The study failed to reject both H_{05} and H_{06} . This study provides critical inputs for future researchers should they decide to explore other risks affecting organizational performance.

Keywords: Supply Risk; Demand Risk; Process Risk; Environmental Risk; Supply Chain Performance; Firm Performance

1. Introduction

Today's global supply networks are experiencing unprecedented challenges. Items considered critical for delivering finished products to customers like raw materials, semiconductors, and port capacity are suffering from shortages (Oltikar, 2021). These shortages brought commodity prices higher than what was expected. These disruptions are brought up by chains of unprecedented events. A good example is the high price and shortages in Aluminum raw material. Aluminum prices hiked abruptly due to high demand and large shortages created by China's orders to cut power use and emissions from smelters and other high-polluting industries (Desai, 2021). There were incidents of machine or human error which have triggered massive logistical delays. One of the largest container ships in the world, The Ever Given, accidentally blocked Egypt's Suez Canal for 106 days (Ebrahim, 2021). The blockage cost global trade an estimate of \$6 billion to \$10 billion weekly and had reduced yearly trade growth by 0.2% to 0.4 %. The blockage also impacted countless businesses from domestic transport providers to retailers and manufacturers (Russon, 2021). Meanwhile, COVID-19 has affected the business environment for many organizations around the world (Hedwall, 2020). This pandemic has severely disrupted the global supply chain and the economy. These events had become disruptions in the supply chain and in the business sectors. Business leaders had to boost

up to sustain business operations, fulfill crucial demands, and reduce supplier challenges against an array of serious disturbances against their teams, personnel, and local communities (Accenture, 2021).

A supply chain is an interconnection of people, enterprise, organization, information, and resources which comprises a series of steps that includes transporting and converting raw materials into finished goods, moving those goods, and delivering them to the customers. A critical part of the business process is the supply chain management (Hayes, 2021). Managing a supply chain is about realizing your business as an interlinked system. It means focusing on your business as part of a long chain of links connected end-to-end, supplying something of value to a customer (Stanton, 2020). Meanwhile, reliable suppliers are required to make a supply chain management process effective and efficient. This means that a supply chain depends on their suppliers to produce quality products that complies with the customer requirements and on time delivery (Hayes, 2021). Acts of God (e.g., floods, hurricanes, and earthquakes), man-made catastrophes (e.g., terrorism, fires, and strikes), and serious legal disturbances (e.g., environmental laws) are considered disruptions in managing supply chains (Ivanov et al., 2017; Ivanov, 2018; Hosseini et al., 2019; as cited in Xu et al., 2020). Disruptions had brought unintended interruption in the day-to-day manufacturing operations. Efficiency of operations were affected by operational waste such as production downtime, expedite fees, and overtime pay. Loss of revenue and/ or customers may arise from poor performance due to disruptions (The COVID-19 Impact on Philippine Business, 2020). In another perspective, approximately 450 million global supply chain workers have faced possible income reduction or job loss due to COVID-19 pandemic. Companies around the world have closed, called off orders, and stopped production. Supply chain workers are among the most vulnerable and most affected by this crisis (Kippenberg, 2021).

In recent five years, the Gross Domestic Product (GDP) growth of the Philippines has averaged within 6.5%, thus ranking the Philippines among the fastest booming economies in Asia. However, the pandemic brought by COVID-19, has created major disruptions in the Philippine economy as expansions, businesses, and overall economic growth fell into a slowdown along with the proclamation of a nationwide lockdown (Reyes, 2021). The GDP growth rate decreased by 16.5% in Q2 of 2020, the lowest documented periodic growth since 1981. The main factors were Transportation & Storage (-59.2%), Manufacturing (-21.3 %), and Construction (-33.5 %) respectively (Philippine Statistics Authority, 2020a). The Philippine supply chain was far no different from other supply chains impacted by these disruptions. Despite being resistant to typhoons, floods, earthquakes, and even volcanic eruption (recent Taal volcano phreatomagmatic eruption), this pandemic caught the Philippines by surprise (*COVID-19 and Its Effects on the Supply Chains in the Philippines*, 2022). Due to COVID-19, an average of 64% of all companies in the Philippines were “Closed Temporarily” (The COVID-19 Impact on Philippine Business, 2020). Filipinos were known to be hardworking and productive. Thus, investors eyed the Philippines for business. Filipinos were known globally as excellent team members, responsible, dependable, and trustworthy (Espinase, 2020). This has motivated the author to investigate how supply chain disruption risks (SCDR) affect supply chain performance (SCP) and firm performance (FP).

This paper has focused on Goal #8 (Decent Work and Economic Growth), supporting the United Nations’ Sustainable Development Goals. Addressing the effects of the supply chain disruptions risks in a proactive approach will help reduce or eliminate the impact to the working population and the nation’s economic growth. (Global Goals, n.d.).

There were few journals and research studies that have tried to quantify the impact of disruptions. Furthermore, there were few massive uncontrollable events and their outcome (Dolgui et al., 2017), which

were documented as reference samples. On the other hand, companies continued to struggle with keeping their supply chain under control, but hidden risks still posed a menacing threat to the industry (Womack, 2020). These prompted the author to conduct this study.

Related Literature

According to Katsaliaki et al. (2021), the more frequently a firm encounters a supply chain disruption, the more we anticipate the company's performance to worsen against its competitors. According to Ngii (2017), 94% of his respondents agreed that it is important to identify supply risks through frequency of occurrence and impact on business. Demand risk, process risk and supply risk occurred frequently (Katsaliaki et al., 2021).

(SDR), demand disruption risk (DDR), process disruption risk (PDR), and environmental disruption risk (EDR). While other studies like Shahbaz et al. (2019), classified supply chain risks as supply side risk, process side risk, demand side risk, logistic side risk, collaboration side risk and environment side risks. Supply and demand uncertainties were among the major risks detrimental to the supply chain performance.

(Sukdeo, 2017). Supply disruption when mediated by organizational productivity both had negative significant relationships on organizational performance (Udofia et al., 2021). According to a survey done with 350 global manufacturers and retailers in July 2020, 73% of the firms have experienced supply-side disruptions due to COVID (Leonard, 2020).

In an enterprise survey done in the Philippines, the report reflected that the pandemic has forced 64% of the firms to close temporarily (67% in the CALABARZON region). The delay in logistics, and importation of raw materials/ goods are among the minor/ severe bottlenecks encountered (The COVID-19 Impact on Philippine Business, 2020). Poor logistics conditions affect the performance of local companies and supply chains. The Philippines ranked 71st in the 2016 Logistics Performance Index (LPI) of the World Bank. According to the World Bank, the logistics sector was recognized as one of the core pillars of economic development (Agcaoili, 2016).

Beyond disruptions on the supply side, demand shock has been disruptive for some commodities, where excess inventory has led to storage capacity shortages and the destruction of perishables. The storage capacity constraints were evident across automobiles and some manufacturing industries. Civil aviation and tourism have been severely hit with a strong negative demand shock in the initial months of the pandemic (International Labour Organization, 2020). Fluctuations in demands have resulted in an uncertain business environment, which then disrupted supply chain performance (Gurtu & Johny, 2021). Unanticipated demand, rush orders, poor delivery, and sourcing constraints, would result in high probability to moderate impact disruptions (Scheibe & Blackhurst, 2017). Demand from customers has decreased with an average of 57.9% nationwide, 53.1% in the CALABARZON region (The COVID-19 Impact on Philippine Business, 2020).

Production risk and skill risk (which were related to process risk) were identified as critical for having high probability, and high impact to supply chain performance (Feng, 2017). Environmental risks were external uncertainties which have emerged from political disruptions (e.g., fuel crisis), natural calamities (e.g., fire, and earthquake), or social (e.g., terrorist attacks) uncertainties (Ngii, 2017). Environmental risks were also defined as damages in the environment which have resulted from day-to-day supply chain operations. Managing the risks would add competitive advantage for corporate reputation and operational performance (Mukhtar et al., 2019). Catastrophic events like natural disasters are recognized to have low likelihood but are destructive events with compelling outcomes to the supply chain network (Scheibe & Blackhurst, 2017).

Higher frequency and higher severity of climate hazards have created more disruptions in the global supply chain (*Could Climate Become the Weak Link in Your Supply Chain*, 2020).

Poor firm performance is a recognized consequence of disruptions. Its undesirable influence is constant across all types of risk (Katsaliaki et al, 2021). Another study confirmed that supply chain risks affect organization performance. Risks that were not identified and defined in the first stages of supply chain risk management were unmanaged (Ngii, 2017). Firms have taken supply chain disruptions more seriously (Bci, n.d.).

According to some literature reviews (114 papers from 1990 to 2015), 56% of the studies have no declared locale, followed by the US (10%), UK (9%), China (4%), and Japan (4%) (Bak, 2018). Published journals tackling issues on the supply chain risk and its effect on the organizational performance in the Philippines setting were scarcely found. It could be that these papers were not publicly published and could be only made available in university research repositories.

The theories of supply chain management in the Philippines remained barely explored in academics and businesses, unlike in developed countries (BusinessMirror, 2020). The proponent of this paper has investigated the effects of disruption risks on supply chains with respect to the organizational performance of manufacturing supply chains within the CALABARZON region.

Conceptual Framework

The conceptual framework presented in Figure 1, provided a full analysis of supply chain disruption risks in terms of representing several forms of risks in a supply chain. Disruption risks from supply-side, demand, process, and environment are the independent variables considered. Supply chain performance and firm performance are the response variables. Parast and Subramanian (2021), used control variables like disruption frequency, disruption durability, disruption familiarity, industry, and firm size, in their study to evaluate the different types of disruption with reference to Chinese supply chain firms.

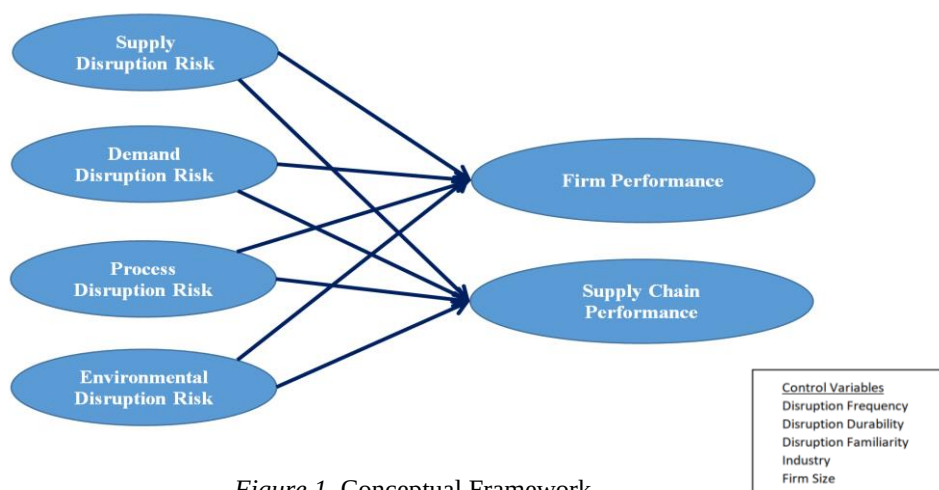


Figure 1. Conceptual Framework

Source: An Examination of the Effect of Supply Chain Disruption Risk Drivers on Organizational Performance: Evidence from Chinese Supply Chains (Parast & Subramanian, 2021).

The results from the study of Parast and Subramanian (2021), showed that disruption frequency has significant effect with firm performance and supply chain performance, while disruption durability has significant effect on supply chain performance. Supply disruption risk has a significant effect on both firm performance and supply chain performance, while demand disruption risk has a significant effect on firm performance. The research did not find any significant effect between demand disruption risk and supply chain performance. On the other hand, the study found a significant effect between process disruption risk on firm performance and supply chain performance. With respect to environment disruption risk, there was no significant effect between environment disruption risk with either firm or supply chain performance.

This paper validates the effects of the same independent and dependent variables, but in the context of Philippine manufacturing firms within the CALABARZON region.

Operational Framework

The operational framework in Figure 2 is guiding this study. Disruption risks from supply-side, demand, process, and environment are the independent variables considered. The two response variables for organizational performance, namely supply chain performance and firm performance, were operationally defined to be at the negative spectrum of performance. In keeping with the researcher's desire to fully adopt the questionnaire wording of Parast & Subramanian (2021), supply chain and firm performance reflected in the questionnaire were measures of poor organizational performance. Consequently, in the data analysis, responses to these questions were reverse coded to reflect positive organizational performance.

However, this paper did not analyze any of the control variables mentioned in the study of Parast and Subramanian (2021). Within the limits of the review of related literature conducted by the researcher, he was unable to find suitable questionnaires to measure disruption frequency, disruption durability, and disruption familiarity. Instead, what he found were questionnaires related to firm size, which measured "total sales", "total assets", and "market value of equity". The confidentiality of these latter stated variables and such information being within the bounds of the data privacy law prohibited the researcher to include any control variable for the current study.

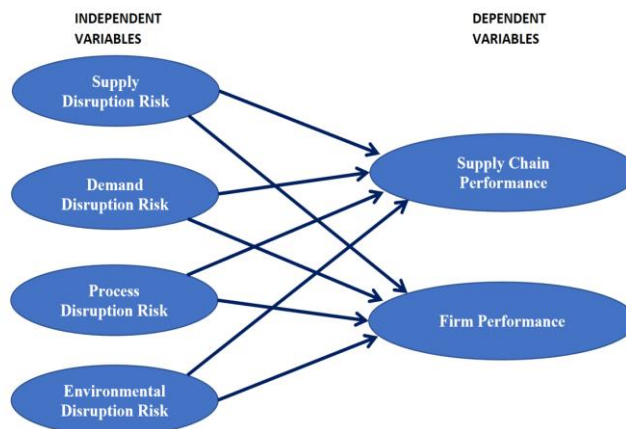


Figure 2. Operational Framework

Objectives

The proponent of this paper focused on the following research objectives to drive an in-depth analysis on the significant effect of the predictor variables with respect to the criterion variables.

1. To determine the significant effect of disruption risks from supply, demand, process, and environment, with respect to supply chain performance.
2. To determine the significant effect of disruption risks from supply, demand, process, and environment, with respect to firm performance.

Hypothesis

The proponent has listed below null hypotheses to be tested in this study.

- H₀₁ – Supply disruption risk has no significant effect on the performance of the supply chain.
- H₀₂ – Demand disruption risk has no significant effect on the performance of the supply chain.
- H₀₃ – Process disruption risk has no significant effect on the performance of the supply chain.
- H₀₄ – Environment disruption risk has no significant effect on the performance of the supply chain.
- H₀₅ – Supply disruption risk has no significant effect on the performance of the firm.
- H₀₆ – Demand disruption risk has no significant effect on the performance of the firm.
- H₀₇ – Process disruption risk has no significant effect on the performance of the firm.
- H₀₈ – Environment disruption risk has no significant effect on the performance of the firm.

2. Methodology

This paper has adopted a quantitative research design approach where variables and hypotheses are fixed and defined (McCombes, 2021). The proponent used descriptive and causal research. Descriptive research is a systematic way of describing a population, phenomenon, or a situation. It answers *what*, *where*, *when*, and results are valid and reliable (McCombes, 2022). Based on the respondents' perception, this paper described the organizational performance of manufacturing companies in Batangas, Laguna, and Cavite in terms of supply chain and firm performance. Causal research is an approach to establish the cause underlying a given behavior and to find the "cause and effect" relationship between different variables. This paper determined the effect of supply, demand, process, and environmental disruption to organizational performance.

The proponent used G*Power sample size calculator with F-Test for multiple linear regression using four predictors, a power of 0.95, an alpha error probability of 0.05, and a medium effect size F^2 of 0.15. This is to capture the appropriate sample size for the study. (Note: the four predictor variables were SDR, DDR, PDR, and EDR). The resulting minimum required participants was 129 respondents. Respondents were taken through purposive quota sampling. Respondents came from manufacturing companies in Batangas, Laguna, and Cavite. This paper focused on describing the respondents' work tenure, the company's length of operation, the respondents' area of work, and the nature of business of the company where the respondents are working. Majority of the respondents are working for >10 years (43%). Most of the companies are operating

for >10 years (77%). Most of the respondents belong to the supply chain, from the electronics / semiconductor business.

According to Undersecretary Mapa (Philippine Statistics Authority, 2020c), CALABARZON region employed a total of 337,560 workers in the manufacturing industry last 2018. The highest share belongs to the electronics industry, 15.2% (51,313 employees). The Philippines electronics industry is classified into Semiconductor Manufacturing Services (73%), and Electronics Manufacturing Services (27%) (*About the Industry*, n.d.).

The instrument used has 29 questionnaires, following a response category of 7-point Likert scale. This was adopted from the 2021 study of Parast, and Subramanian. The respondents were given the option to take the survey online or through a printed survey questionnaire. For the online survey, the link to the online survey questionnaire was sent to the participant's email address. Information gathered from the online surveys were treated with anonymity and confidentiality.

The research instrument underwent a reliability test. Table 1 shows Cronbach's alpha loadings of the chosen variables.

Table 1. Cronbach Alpha Findings

Part	Items (Variables)	Cronbach Alpha
I.	Supply Disruption Risk	0.938
II.	Demand Disruption Risk	0.937
III.	Process Disruption Risk	0.955
IV.	Environmental Disruption Risk	0.942
V.	Supply Chain Performance	0.964
VI.	Firm Performance	0.970
Overall		0.981

Overall, the instrument passed, resulting in Cronbach's alpha of 0.981. Cronbach's Alpha reliability coefficient normally ranges between 0 and 1 however, there is no limit to the coefficient. The closer Cronbach's Alpha coefficient is to 1.00 the greater the internal consistency of the items in the scale. George and Mallory (2003, as cited in Schrepp, 2020) provided the following techniques: a) > 0.90 = Excellent; b) 0.80-0.89 = Good; c) 0.70-0.79 = Acceptable; d) 0.60-0.69 = Questionable; e) 0.50-0.59 = Poor; and f) <0.50 = Unacceptable.

This paper used multiple linear regression as the inferential analysis tool to analyze the association of the independent variables with respect to the dependent variables, as stated on the hypothesis. If the resulting p-value is less than 0.05 (≤ 0.05), then there is strong evidence against the null hypothesis, thus the null hypothesis will be rejected.

Table 2 presents how the questionnaires were responded and interpreted.

Table 2. Response Categories and Interpretation

Measurement: 7-point Likert Scale		Response Categories	
Variables	Mean Range	Risk Impact	Performance
Disruption Risks	1.000 – 1.857	No Risk	Extremely Poor
▪ Supply risk	1.858 – 2.714	Very Low	Very Poor
▪ Demand risk	2.715 – 3.571	Low	Poor
▪ Process risk	3.572 – 4.428	Moderate	Average (Neither Good nor Poor)
▪ Environmental risk	4.429 – 5.285	High	Good
	5.286 – 6.142	Very High	Very Good
	6.143 – 7.000	Critical	Excellent

Risk can have a positive or negative impact on “Performance”. The word “Risk” carries a negative meaning. A negative risk is perilous, and when it happens, it becomes a hazard. However, a risk can become positive by providing a chance for improvement for the organization (Bisson, 2014).

The proponent of this study opted to reverse-code the response data for the supply chain performance and firm performance prior to the statistical analysis. The negative response from the survey questionnaires may bring confusion to the future readers of this paper. Thus, it is very important for the proponent to reverse code the response data for the supply chain performance and firm performance. This is to reflect the effects of the four supply chain disruption risks to the ideal measurement for performance. Hence, the goal was to measure the negative effect of risks with respect to ideal performance.

The proponent had sought the consent from the respondents on the ethical considerations applied to this study. Participation on the online survey was voluntary. Personal and/ or company information of the participants were treated with confidentiality. Only general responses were disclosed. Participants were not subjected to any harm or threat. Respect for the dignity of the research participants was also prioritized. Respondents’ protection to privacy were upheld accordingly.

3. Results and Discussion

This section contains the analyses performed with the data using the appropriate statistical tools and achieved the following outcomes.

Perception on the Four (4) Disruption Risk

Supply Disruption Risk (SDR)

Table 3 presents the descriptive statistics on the respondents’ perception of SDR. The respondents perceived “capacity fluctuation/ shortages on the supply pipeline” ($M = 5.26$), “supplier quality problems” ($M = 4.87$), “poor supplier logistics performance” ($M = 4.71$), and “poor performance of logistics service provider” ($M = 4.57$), as “High”. This indicates above four items under SDR have a high negative impact on the supply chain management.

Table 3. Perception of Supply Disruption Risk

Items	Mean	Std. Dev	Interpretation
Poor supplier logistics performance (e.g., order fill capacity)	4.71	1.692	High
Supplier quality problems	4.87	1.729	High
Sudden supplier demise (e.g., bankruptcy)	4.18	1.966	Moderate
Poor logistics performance of logistics service provider	4.57	1.704	High
Capacity fluctuations or shortages on the supply pipeline.	5.26	1.574	High
SDR	4.72	1.527	High

According to Attinasi (2022), semiconductor and labor shortages are dragging the trade industry globally. During the 2020 lockdown, car producers cut down their chip orders, but there was a sudden upsurge on new car orders in Q3 2020. With limited spare capacity left in the semiconductor industry, chip production was not able to keep up with the high demand. Supplier quality is a major concern in the supply chain. Manufacturing firms must ensure their supplier partners maintain high-quality standards, processes, and products. Companies should watch for degrading quality, missed on time deliveries, and slow communication. In maintaining supplier quality, managing errors relating to specifications are some of the major challenges. It is highly important that a supplier's raw materials, parts, or processes meet the requirements of the manufacturers ("Supplier Quality During a Major Supply Chain Disruption Like COVID-19," 2021). In terms of logistics, The LPI Report released by the World Bank (2018), confirms that Logistics in the Philippines have a lot to be improved. The Philippines ranked #64. The LPI report states that the Philippines needs to improve in Customs (#70), Infrastructure (#71), Timeliness (#83), Logistics Quality and Competence (#64).

Meanwhile, sudden supplier demise ($M = 4.18$) is perceived as "Moderate". This is supported by the survey of Asian Development Bank, (The COVID-19 Impact on Philippine Business, 2020), where there are only 0.6% of the businesses in CALABARZON that were permanently closed after the Enhanced Community Quarantine. There are businesses that are still open but with limited operations (28%), and there are establishments that are only temporarily closed (67.1%).

Demand Disruption Risk (DDR)

Table 4 presents the descriptive statistics on the respondents' perception of DDR. The respondents perceived "Unanticipated demand or very volatile demand" ($M = 4.74$), "Insufficient information from customer" ($M = 4.56$), and "Customer request to expedite pending orders" ($M = 4.55$), as "High". This means that above three items under demand disruption risk have high negative impact on the supply chain management. "Unusual customer payment delays" is perceived as "Moderate".

Table 4. Perception of Demand Disruption Risk

Items	Mean	Std. Dev	Interpretation
Unanticipated demand / very volatile demand	4.74	1.503	High
Insufficient/ distorted information from customer's order/ demand quantities.	4.56	1.541	High
Unusual customer payment delays	3.92	1.628	Moderate
Request from the customer to expedite pending order/s.	4.55	1.505	High
DDR	4.44	1.390	High

According to Julie Gerdeman, CEO of Everstream Analytics, “we are always going to get unpredictable surges in demand” (*Supply Chain Risks in 2022: Year in Review*, n.d.). According to Remes et al., (2021), there is an unexpected surge in demand for consumer products. Suppliers were surprised by the surge in goods demand. This surge in turn led to bottlenecks in critical supplies that affect the production of consumer products from cars to computers. This denotes that supply has not kept up with the soaring demand. There are unexpected increases in commodity prices and shortages (*Shortages of Everyday Products Have Become the New Normal. Why They Won't End Soon.*, 2021)

Process Disruption Risk (PDR)

Table 5 presents the descriptive statistics on the respondents' perception of PDR. The respondents perceived “Downtime due to local disruption like fire or labor strike” ($M = 4.18$), “Production capacity loss due to technical reasons” ($M = 4.15$), “Breakdown of External IT Infrastructure” ($M = 4.02$), and “Breakdown of Internal IT Infrastructure” ($M = 3.93$), as “Moderate”. This indicates all four items have moderate (average) impact on the supply chain management.

Table 5. Perception of Process Disruption Risk

Items	Mean	Std. Dev	Interpretation
Downtime or production capacity loss due to local disruptions (e.g., fire, labor strike)	4.18	1.873	Moderate
Breakdown of “Internal” IT infrastructure (e.g., virus, malware)	3.93	1.863	Moderate
Production capacity loss due to technical reasons (e.g., machine deterioration)	4.15	1.737	Moderate
Breakdown of “External” IT infrastructure (e.g., servers, ISP)	4.02	1.813	Moderate
PDR	4.07	1.714	Moderate

All items are “Moderate” in risk. Most of the electronics, semiconductor, and automotive assemblers are in this region. (Department of Trade and Industry, n.d.). These ISO9001 certified companies have stricter controls over their business processes (Nagaraja, 2022).

Environmental Disruption Risk (EDR)

Table 6 presents the descriptive statistics on the respondents' perception of EDR. The respondents perceived “Disease, Epidemic, Pandemic” ($M = 5.20$) and “Natural disasters” ($M = 4.57$) as “High”. This means that the above two items under environmental disruption risk have a high negative impact on the supply chain management. This is supported by the fact that 67% of 64% of the companies that temporarily closed due to COVID-19 are from the CALABARZON region. The latter is due to the phreatomagmatic eruption of Taal volcano in January 2020. Survey was taken when the pandemic was still at surge, and the volcanic activity of Taal volcano was still unpredictably unstable.

Table 6. Perception of Environmental Disruption Risk

Items	Mean	Std. Dev	Interpretation
Political instability, war, civil unrest, or socio-political crisis	3.85	1.962	Moderate
International / local terror attacks (e.g., ISIS, NPA, Abu Sayyaf)	3.48	1.969	Low
Disease, Epidemic, Pandemic (e.g., EBOLA, SARS, MERS, COVID-19)	5.20	1.593	High
Natural disasters (e.g., Volcanic Eruption, Typhoon, Tsunami, Earthquake)	4.57	1.727	High
Changes in political environment (New laws, regulations, etc.)	3.79	1.708	Moderate
Admin barriers for the setup or operation of supply chain (e.g., authorizations, etc.)	3.72	1.695	Moderate
EDR	4.10	1.568	Moderate

Results indicate that “Political instability” ($M = 3.85$), “Change in Political Environment” ($M = 3.79$), and “Admin barriers” ($M = 3.72$), have “Moderate” impact on Environment Disruption Risk. While “International / local terror attacks” ($M = 3.48$), shows “Low” impact. This response may be attributed to the fact that, most of the terror attacks / military encounters in recent years including the famous Mamasapano (July 2016) and Marawi (May 2017) incidents were within the Mindanao regions. NPA (New People’s Army) attacks in the Philippines from January 1, 2018, to February 14, 2021, were concentrated in the regions of Bicol, Caraga, Eastern Visayas, Central Visayas, Western Visayas, Davao, and Northern Mindanao (Alifandi, 2021). This proves that the CALABARZON region is a haven for more investments in the future. The CALABARZON region is building up its position as the leader of the manufacturing and industrial hub of the Philippines. More foreign and local investors are expected to visit and do business in the region. (Gomez, 2022). In a report, AYALALAND Logistics Holdings Corp. acquired 55 hectares of land in Batangas. The new Batangas Technopark will be the fifth industrial park in the CALABARZON region (Jocson, 2022). In another report, the registration of QTISEZ - Quezon Techno-Industrial Special Economic Zone, an 1,836-hectare project in Quezon Province, was approved by the Philippine Economic Zone Authority for PHP 125 billion. This will be the largest economic zone in the country. Achievement Realty Corporation will be allocating PHP75 billion for ecozone development, and PHP25 billion each for its own international seaport and airport. This project (QTISEZ) will house 2,000 factories and will create 200,000 jobs (Crismundo, 2022).

Summary of Perceptions of the Four (4) Supply Chain Disruption Risk (SCDR)

Table 7 presents the descriptive summary of the respondents’ perception on the four SCDR. The respondents perceived SDR ($M=4.72$), and DDR ($M=4.44$) as “High”, while EDR ($M=4.10$), and PDR ($M=4.07$), were perceived as “Moderate”.

Table 7. Perception on Four Supply Chain Disruption Risk

Risk Types	Mean	Std. Dev	Interpretation
SDR	4.72	1.527	High
DDR	4.44	1.390	High
PDR	4.07	1.714	Moderate
EDR	4.10	1.568	Moderate

Risk on the supply-side was influenced by the importation of raw materials, and other commodities like chemicals from outside the Philippines. Imports decreased by 11.6% (from USD 7.98 million to USD 7.06 million). Import of electronic products, contributed the highest share of 28.3% to the total imports. However, import of this commodity declined by 2.4% in February 2020 from USD 2.05 million in February 2019. Imports of raw materials and intermediate goods dropped by 8.7%, from USD 2.91 billion in February 2019 (Philippine Statistics Authority, 2020b). Risk on the demand-side was influenced by the volatility of demands from the customer due to pandemic. Demand from customers has decreased by 57.9% nationwide, 53.1% in the CALABARZON region (The COVID-19 Impact on Philippine Business, 2020).

Perception on Supply Chain Performance (SCP)

Table 8 presents the descriptive statistics of the respondents' perception on Supply Chain Performance. The respondents perceived "Drop in delivery speed" ($M=3.46$), and "Drop in delivery dependability" ($M=3.56$) to be statistically "Poor" in performance. While "Drop in customer satisfaction" ($M=3.67$), and "Drop in order fill capacity" ($M=3.79$) are "Average" in performance.

Table 8. Perception on Supply Chain Performance

Items	Mean	Std. Dev	Interpretation
Drop in order fill capacity	3.79	1.339	Average
Drop in delivery dependability	3.56	1.414	Poor
Drop in customer satisfaction	3.67	1.563	Average
Drop in delivery speed	3.46	1.484	Poor
SCP	3.62	1.377	Average

Data shows that the respondents have experienced poor delivery speed and poor delivery dependability in their respective supply chains for the past three years. This would likely be the impact of COVID-19 pandemic in the supply chain. However, some respondents may have not experienced any problem on order fill capacity and customer satisfaction, from their respective supply chains.

In the supply chain, speed of delivery is very important. In choosing suppliers, aside from cost, and quality, speed of delivery is among the winning factors for a supplier to get more business with the company. The faster the raw materials, hardware, and accessories, packing materials, and other purchased products arrive, the sooner the manufacturing can start production / assembly. Suppliers with the fastest / shortest lead-time may get more repeat orders than those with longer lead-time. In the past 3 years, respondents may have observed that there is high risk on delivery speed. The disruption on the supply side and logistics/ transportation have slowed down suppliers, and somehow prevented these suppliers from delivering as fast as they were before. Recent lockdowns, and manpower shortages on truck drivers, created port congestions. Moreover, the stricter protocols imposed from country to country, or port to port, have caused more delays in processing these deliverables.

Suppliers are expected to deliver on time on the agreed delivery date. Actual quantity must tally with ordered quantity. The respondents perceived that in the last three years, there is high risk on the delivery dependability. The disruption on the supply side has created delays on the delivery schedules. It has created shortages of stocks for suppliers to commit to full quantity delivery. Companies recently experienced increased incidents of partial delivery, or push outs, from the suppliers.

Perception on Firm Performance (FP)

Table 9 presents the descriptive statistics of the respondents' perception on Firm Performance. The respondents perceived "Drop in overall product quality" ($M=3.77$), "Drop in overall customer service" ($M=3.78$), "Drop in overall competitive position" ($M=3.83$), "Drop in market share" ($M=3.90$), "Drop in average selling price" ($M=3.91$), and "Drop in return of assets" ($M=4.13$) to be "Average" in performance with respect to firm performance.

Table 9. Perception on Firm Performance

Items	Mean	Std. Dev	Interpretation
Drop in return on assets	4.13	1.563	Average
Drop in overall product quality	3.77	1.792	Average
Drop in overall customer service levels	3.78	1.691	Average
Drop in market share	3.90	1.648	Average
Drop in average selling price	3.91	1.611	Average
Drop in overall competitive position	3.83	1.737	Average
FP	3.89	1.582	Average

The "average" performance of these risks only shows that respondents have considered these risks as normal in the organization. These risks are controllable internally in the organization. Internal factors influence firm performance. While external factors (suppliers, customers) influence supply chain performance. Moreover, the survey was taken at a time when the lockdowns were already lifted, and respondents were able to go back to work.

Effect of Supply Chain Disruption Risks (SCDR) on Supply Chain Performance (SCP)

Table 10 presents the effects of all four supply chain disruption risks on supply chain performance. Data reveal that SDR ($\beta = -0.33$, $p\text{-value} < 0.05$), and DDR ($\beta = -0.32$, $p\text{-value} < 0.05$), statistically have "significant" effects on SCP. Meanwhile, PDR and EDR, having $p\text{-values} > 0.05$, are statistically "not significant" with respect to SCP.

Table 10. Effects of Supply Chain Disruption Risks on Supply Chain Performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value	Interpretation
		β	Std Error	beta			
1	(Constant)	7.32	0.24		30.31	0.00	
	SDR	-0.30	0.09	-0.33	-3.34	0.00	Significant
	DDR	-0.31	0.09	-0.32	-3.42	0.00	Significant
	PDR	-0.12	0.08	-0.15	-1.55	0.13	Not Significant
	EDR	-0.10	0.07	-0.12	-1.43	0.15	Not Significant
R ² = 0.695		F value = 70.81		p-value = .000			

Dependent Variable: Supply Chain Performance

Having the R^2 of 0.695 means a moderate to strong effect size (Moore, 2013). A change in the predictor variables would predict 69.5% of the variance in SCP. Since R^2 is considered high, it shows that the model fits the data.

A multiple linear regression was used to predict SCP based on four predictors (SDR, DDR, PDR, EDR). Found the regression equation ($F(4,124) = 70.81, p < 0.00$), with an R^2 of 0.695 to be significant. Respondents predicted supply chain performance is equal to $7.32 - 0.30(\text{SDR}) - 0.31(\text{DDR}) - 0.12(\text{PDR}) - 0.10(\text{EDR})$. A negative Beta coefficient would mean that SDR, DDR, PDR, & EDR will adversely or negatively affect SCP. SCP will decrease by 33% for every unit increase in SDR. SCP will decrease by 32% for every unit increase in DDR. SCP will decrease by 15% for every unit increase in PDR. Lastly, SCP will decrease by 12% for every unit increase in EDR.

The study of Parast and Subramanian (2021), reflected SDR to have significant effect on SCP ($\beta = 0.380, p\text{-value} < 0.05$), but not with DDR, where the results showed DDR has no significant effect on SCP ($\beta = 0.067, p\text{-value} < 0.10$). SDR and DDR have significant effects on SCP (Shahbaz et al., 2020). Mukhtar et al. (2019), published that environmental risk affects supply chain operation, while Ongkowijoyo et al. (2020), states that pandemic-level disruptions are considered severe supply chain disruptions affecting SCP.

Effect of Supply Chain Disruption Risks (SCDR) on Firm Performance (FP)

Table 11 presents the effects of all four supply chain disruption risks on firm performance. Data shows that PDR ($\beta = -0.52, p\text{-value} < 0.05$), and EDR ($\beta = -0.22, p\text{-value} < 0.05$), statistically have “significant” effects on FP. While SDR and DDR, having $p\text{-values} > 0.05$, are statistically “not significant” with respect to FP. Having the R^2 of 0.725 means a strong effect size (Moore, 2013). A change in the predictor variables would predict 72.5% of the variance in FP. Since the R^2 is considered high, it shows that the model fits the data.

Table 11. Effects of Supply Chain Disruption Risks on Firm Performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value	Interpretation
		β	Std Error	beta			
1	(Constant)	7.62	0.26		28.90	0.00	
	SDR	-0.15	0.10	-0.15	-1.58	0.12	Not Significant
	DDR	-0.03	0.10	-0.03	-0.31	0.76	Not Significant
	PDR	-0.48	0.09	-0.52	-5.70	0.00	Significant
	EDR	-0.22	0.08	-0.22	-2.83	0.01	Significant
R ² = 0.725		F value = 81.75		p-value = .000			

Dependent Variable: Firm Performance

A multiple linear regression was used to predict FP based on four predictors (SDR, DDR, PDR, EDR). Found the regression equation ($F(4,124) = 81.75, p < .000$), with an R^2 of 0.725 to be significant. Respondents

predicted firm performance is equal to $7.62 - 0.15 (\text{SDR}) - 0.03 (\text{DDR}) - 0.48 (\text{PDR}) - 0.22 (\text{EDR})$. A negative Beta coefficient would mean that SDR, DDR, PDR, & EDR will adversely or negatively affect FP. FP will decrease by 15% for every unit increase in SDR. FP will decrease by 3% for every unit increase in DDR. FP will decrease by 52% for every unit increase in PDR. Lastly, FP will decrease by 22% for every unit increase in EDR.

From the study of Parast and Subramanian (2021), process disruption risk has a significant effect on firm performance ($\beta=0.137$, $p\text{-value} < 0.05$), but it supports no significant effect found from environmental disruption risk on firm performance ($\beta=0.001$, $p\text{-value} > 0.10$). Any facility disruption in the supply chain may lead to catastrophic consequences (Yan & Ji, 2019). From a survey by the World Bank (2020), it was published that the recent pandemic had a significant impact on the firm's operations. About 15% of firms have closed permanently. Firms expressed a high degree of uncertainty about their operations. This will likely limit investment and employment, restraining the firm's growth. Business transactions were expected to slow down.

Conclusion

Only SDR and DDR have significant and negative effects on SCP ($p < 0.05$), as shown by the data from multiple regression analysis. Thus, both H_{01} and H_{02} were rejected. The study failed to reject both H_{03} and H_{04} . On the other hand, only PDR and EDR have significant and negative effects on FP ($p < 0.05$). Thus, both H_{07} and H_{08} were rejected. The study failed to reject both H_{05} and H_{06} . Therefore, in the context of organizational performance in companies within Philippines' CALABARZON region, this study confirms that risks emerging from the supply and demand side greatly affects the supply chain performance (SCP). However, process and environmental risks have minimal effect on SCP. This means that disruptions from the process such as machine breakdown, and environment related disruptions like typhoons or the recent pandemic, have minimal impact on SCP. On the other hand, process risks and environmental risks greatly affect firm performance (FP). While risks from supply and demand barely affect FP. This means risks from the supply and demand side have no direct impact on FP.

Recommendation

The resilience of the supply chain is vital in the success and survival of any manufacturing organization. It is important for the supply chain in companies within the CALABARZON region to be proactive in the identification, and mitigation of these supply chain disruption risks. Supply chain and organization leaders need to prioritize and focus on addressing the factors that trigger the existence of disruption risks from supply side, demand side, process, and the environment.

Forward planning on the supply and demand is vital for all supply chains. It is crucial to foresee any potential disruptions that may become a risk on the supply chain. Review of the supply pipeline for raw material scarcity, logistics issues, supplier capacity issues, and poor supplier quality performance are critical to ensure that potential disruptions at the supply side can be addressed ahead of time. Supply chain in the Philippines must develop strategies that promote localization or regionalization of parts. This is to develop suppliers within reach to avoid single sourcing and promote flexibility (dual sourcing). Supply chain must have programs to promote continuous improvement to its suppliers. Collaboration with Supplier Quality and/

or Supplier Development groups are essential. Supply chain must work together with the logistics team to ensure inbound and outbound shipments are tracked effectively. Hub consolidation, and supplier-managed inventories, are potential strategies that both the supply chain, logistics, and the suppliers can work together to ensure that parts are available and get delivered on time. More infrastructures (e.g., airports, seaports, bridges) will improve logistics performance. Investments on “digitization” and “automation” of customs transactions will eliminate manual interventions and speed up processing time. Supply chain must also strengthen communication with the planning team to ensure demands from customers are clear. Any change in demand must be checked for impact on existing orders.

The employees are the most important assets of any organization. Operation managers must develop strategies to strengthen the health system in their respective companies. The health and safety of the entire workforce must be among the top priorities of the stakeholders. Data from this study show that the higher the occurrence of environment risk events (e.g., pandemic, natural disasters) the lower the performance of the firms in the CALABARZON region. Operation managers must review risks from all potential sources (internal / external). Employees must be trained to be risk proactive. They should be able to handle any risk with proper control and mitigation. Operations must include operational risk as part of their periodic risk assessment. People risk, systems risk, financial risk, and compliance/ legal risk should also be assessed.

Future researchers are encouraged to study the effects of cyber-attacks, and how to strengthen cybersecurity, and data integrity in supply chains. Future researchers of supply chain risks may also include the study of the positive effects of risks to the supply chain performance. The mother journal of this paper only focused on the negative effects of the risks. There is a lot to explore in studying the positive effects of supply chain risks to the organization. Then compare the effect of positive risk with that of the negative risk.

Limitation of the Study

Control variables from the mother journal were not adopted due to data privacy restrictions from participating companies. Rizal and Quezon province were not surveyed due to local pandemic travel restrictions. This study was limited on risks from supply side, demand side, process side and environment side. Other potential sources of risks were not considered in this study.

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